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A. D. MELVIN, CHIEF OF BUREAU.

METHODS FOR THE ERADICATION OF GID.

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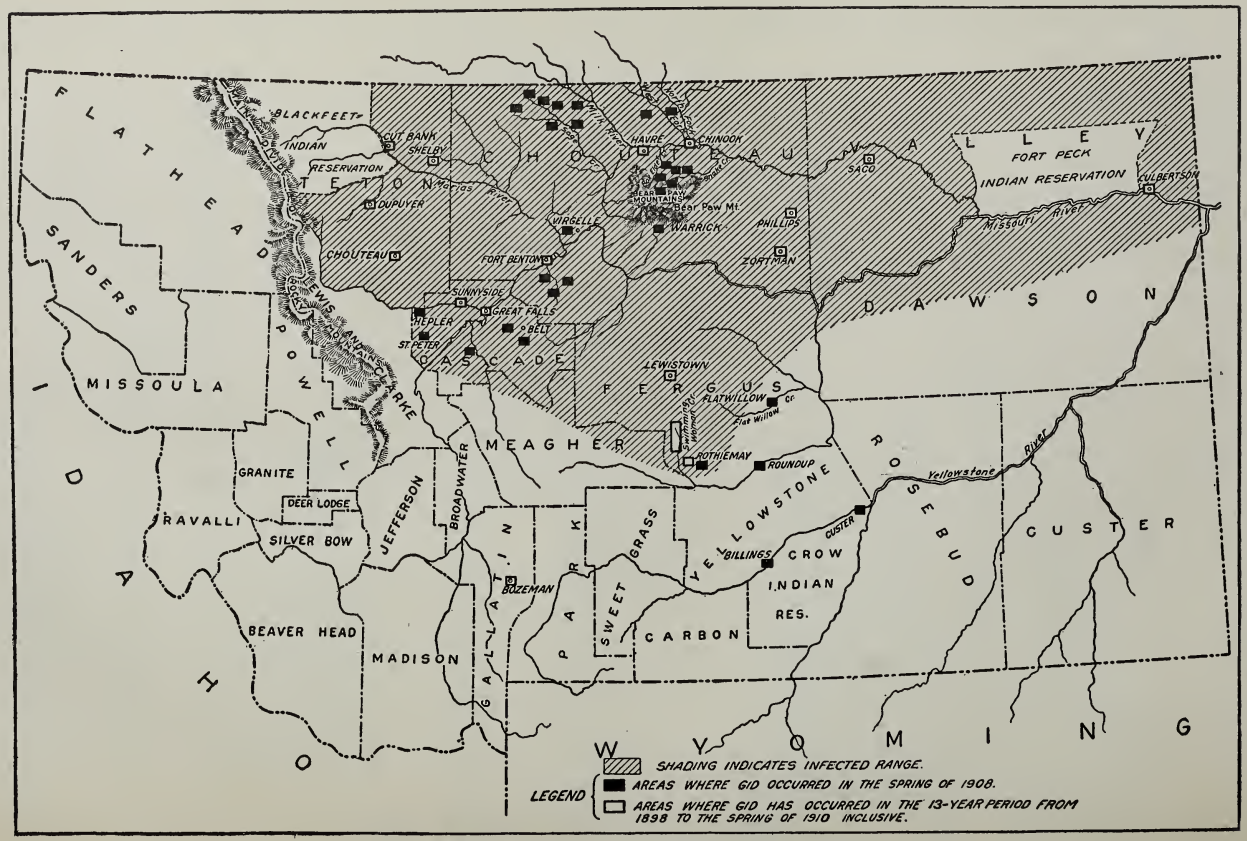


FIG. 1.—Map of Montana, showing distribution of gid in sheep.

METHODS FOR THE ERADICATION OF GID.

PRESENCE OF GID IN THE UNITED STATES.

For over a century claims have been published to the effect that the sheep disease known as gid existed in the United States. Abundant evidence indicates that it certainly has had a foothold in this country for over twenty years. During this period it has been reported, apparently correctly, from New York, Ohio, Illinois, Iowa, Michigan, Missouri, Kansas, Indian Territory, Montana, and Nevada. In many of these cases the diseased animals appear to have been imported, in some cases from Europe; but in at least three of these States—New York, Iowa, and Montana—the disease has been acquired from infected range or pasture. The cases in New York occurred in 1909 and those in Iowa in 1910. In Montana the range has been infected for at least twenty years, and during that period the infected area has increased until a territory 400 miles long and in places 200 miles wide is infected range. This area is in northern Montana and includes Teton, Chouteau, Valley, and Cascade counties and the northern part of Meagher, Fergus, and Dawson counties. (See map, fig. 1.) From outside of this area come numerous reports of cases of gid in Montana, but such cases usually have a history indicating that they were brought from the infected northern area. Such movements of sheep constitute the means whereby the total infected area may be increased in the future as it has been increased in the past to its present extent.

LOSSES FROM GID.

The evidence obtained by the writer in an investigation of gid in Montana in the spring of 1910 indicates that the total loss from gid is at least $10,000 in some years. The extent of the loss is not appreciated by most sheepmen, as the disease is not known by name or is mistaken for other things even by sheepmen who have lost sheep from it for twenty years. The great majority of them confuse it with loco disease and call it by this name. In one place where there was no loco and it was evident that the disease could not be loco disease, gid was known as "lamb loco" from the well-known fact that lambs and yearlings are most susceptible to it. Another reason why the extent of the loss from this source is not appreciated is that

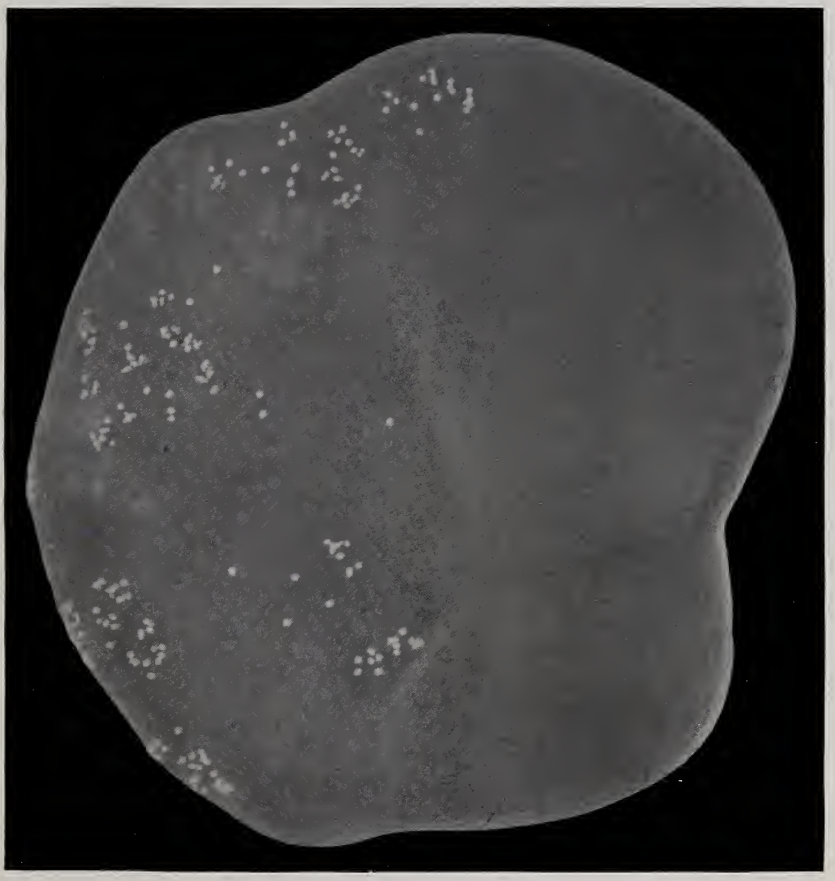
giddy sheep tend to stray from the flock and fall a prey to coyotes, and in some outfits giddy sheep are left behind when they become difficult to herd and these are also eaten by coyotes. The losses reported vary from 2 or 3 to 400, being at times 10 per cent of the entire flock. Some sheepmen lose more sheep from gid than from any other cause.

DESIRABILITY OF ERADICATION.

Such losses alone would justify vigorous efforts to eradicate the disease. The history of the disease in Europe adds additional reason for prompt eradication of the disease from the United States. The present comparatively small loss of $10,000 a year from gid in this country is not the only thing to be considered. The fact that gid has gained a foothold in the United States means that the disease, unless controlled, will become more widespread in the future and will probably cause losses of many times $10,000 a year. Furthermore, the more widely disseminated the disease becomes, the more difficult and costly it will be to eradicate it. For over half a century European flocks have suffered a steady and considerable loss from this disease in spite of the fact that during that time there has been adequate knowledge of measures for its suppression. It remains to be seen whether the sheepmen of Montana can eradicate a disease which the farmers and peasantry of Europe have been unable to eradicate. The Bureau of Animal Industry is confident that such a thing can be accomplished in the case of gid, as it has been accomplished in the case of foot-and-mouth disease and of contagious pleuro-pneumonia of cattle. Both of these diseases have obtained a foothold in the United States and have been eradicated in spite of the fact that European countries have been unable to accomplish such results. Compared with the elimination of these diseases or the struggle against Texas fever, the eradication of gid is a very simple matter. The symptoms are very striking and readily recognized by any sheepman, and the method by which the disease may be prevented is child's play compared with the treatment involved in handling such disease as lip-and-leg ulceration.

LIFE HISTORY OF THE GID PARASITE.

Gid is a disease due to the presence in the brain, or, rarely, in the spinal cord of the sheep of a larval tapeworm parasite having the general appearance of a fish bladder full of water (see Pl. I and figs. 2 and 11). This parasite is commonly known by the scientific name *Cœnurus cerebralis*, but the correct name is *Multiceps multiceps*. It is translucent and at times larger than a hen's egg. On this bladder are a number of white objects about the size of a grain of wheat and projecting, usually, into the fluid with which the bag is filled. These



Gid Parasite from Brain of Sheep.

The heads on the upper and lower surfaces and in some cases the openings of the necks to the exterior of the parasite are shown. (Slightly reduced.)

objects are tapeworm heads. On feeding this bladderworm, as the gid parasite is called, to a dog, the bladder digests, but the tapeworm heads pass on to the intestine, where they add segment after segment back of the head, till in the course of a month or two each head has become the head of one of the familiar segmented tapeworms, the worms in this case becoming 2 or 3 feet long (see fig. 3). Having attained this size, the posterior segments (see fig. 4), which contain hundreds of very small tapeworm eggs, begin to break off and are passed out onto the range or pasture with the feces. Under favorable conditions these eggs (fig. 5) are washed onto the grass or into standing or running water, and sheep eating grass or drinking water so infected thereby take the eggs into the stomach. Here the shell digests off and a very small embryo, armed with six hooks, bores its way through the walls of the digestive tract by means of these hooks, gets into the blood vessels, and is swept around till it lodges. In any location except the brain or spinal cord the parasite may grow to the size of a pea, but at that point or sooner it degenerates and dies. Those that get to the brain or spinal cord develop into the bladderworm described above.

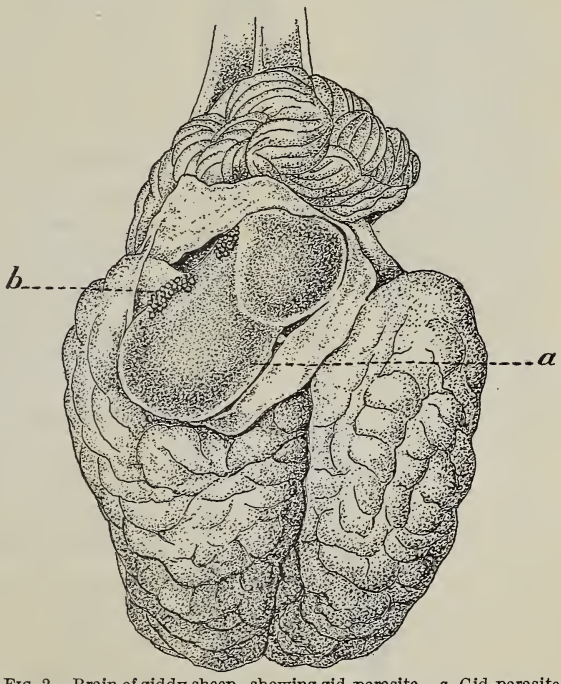


FIG. 2.—Brain of giddy sheep, showing gid parasite. *a*, Gid parasite or bladderworm; *b*, heads on bladderworm. (After Numan, 1850, Pl. I, fig. 1.)

At the time when the embryos get to the brain and begin to travel on its surface or through its substance there are usually slight symptoms of fever and restlessness, which are easily overlooked. Should the infection be severe enough to kill the sheep at this stage, an examination of the brain will disclose a number of curving channels on its surface. (See fig. 6.) But as a rule these symptoms abate and there is no further indication of the presence of the parasite until it has grown to the point where the heads form on the bladder and set up the symptoms characteristic of the last stages of gid by projecting out of the bladder and into the brain. This is accomplished by

virtue of the fact that the head is seated at the bottom of a little tubular neck with an opening to the exterior. Ordinarily this neck projects into the bladder fluid; but the head and neck can be projected through the opening mentioned, the neck turning inside out, just as a glove finger might be turned inside out. (See fig. 7.) When the head is pushed out it brings the crown of hooks with which it is armed into contact with the brain, and it is to the irritating action of these hooks on the brain that such symptoms as walking in a circle are ascribed. It seems probable that only such symptoms as circling or running or jumping without apparent cause, which are of an intermittent and occasional sort, should be referred to the action of the tapeworm heads. Such symptoms as are constant in the last stages of the disease, including blindness, constant carriage of the head to one side, loss of appetite, and the like, should probably be referred to atrophy of the brain due to the pressure of the parasite, and to other nervous disturbances resulting from this pressure.

FIG. 3.—Adult gid tapeworm from the dog. Natural size. (Specimen No. 4031, Bureau of Animal Industry helminthological collection.)

The final symptoms of gid do not show until seven or eight months after the sheep has become infected, the sheep usually dying about nine months after the time of infection. This point is important, because the Montana sheepmen, being unacquainted with the true nature of the disease, have been inclined to attribute gid to the nature of the country in which the sheep were feeding at the time of the outbreak, and it is difficult to convince them that the infection was more or less remote from the range where the outbreak occurs.

LIFE HISTORY IN RELATION TO MONTANA CONDITIONS.

The actual history of the disease in most cases in Montana seems to be about as follows: The developed larval parasite, capable of infecting the dog, is found in sheep mostly while on the winter range from December to the end of March, exceptional cases occurring outside of this period. The adult worms develop in dogs, and probably

in coyotes and other wolves also, from eating the heads of sheep dying of gid during the months mentioned. These worms require a month or two to develop to the point where the tapeworm eggs are passed with the feces, and eggs from dogs infected at this time are probably being spread over the pasture and range any time after the 1st of February. Up to the time of the spring rains it is unlikely that many sheep become infected. It is the common testimony of writers on this subject that sheep avoid eating grass covered with fecal deposits, and it is likely that up to the time of the rains the eggs would generally lie alive and untouched or else perish. A number of writers have stated that dog feces act as a fertilizer and cause a fine growth of grass, thus attracting sheep to the spot where defecation occurred and leading to the infection of the sheep. This theory is probably far from the fact. When sheep and dogs in their usual numerical ratio are on the same pasture or range, the crop of grass over the entire area would owe much less to the dog feces than to the sheep feces, and the growth for equal amounts of feces of both sorts would be less for those of the dog. Finally, the tapeworm eggs would have perished long before the dog feces had weathered and decomposed to the point where they became good fertilizer and the grass had responded to this by a noticeably improved growth. It is only as the feces are promptly broken up by water and the eggs released that sheep are liable to become infected. From the time the spring rains set in—usually during May, it is said—the sheep, now on summer range, take up the infection. The beating rain breaks up the dog feces, washes the tapeworm eggs into puddles and reservoirs from which the sheep drink, and splashes them on the grass which the sheep eat. Allowing the usual nine months' period of development, sheep infected in May will die in December. The deaths from January to March, inclusive, indicate that the storms of June, July, and August play a part in the infection of sheep. From this time dry weather apparently saves the sheep from further infection on the summer range, and on removal to

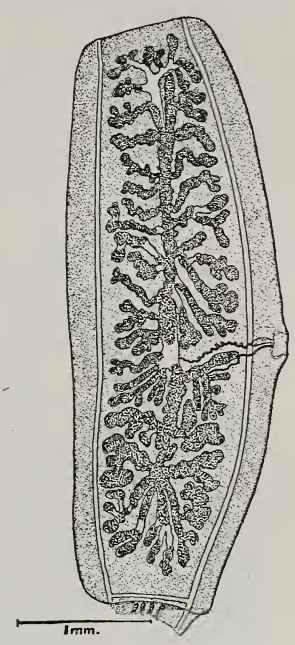


FIG. 4.—Gravid segment of gid tapeworm, showing the branching uterus full of eggs. (Specimen No. 4031, Bureau of Animal Industry helminthological collection.)

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FIG. 5.—Egg of gid tapeworm.

winter range cold weather probably serves to keep the feces frozen, and thereby prevents them from breaking up and washing about. The death at this time of sheep infected the previous spring and summer gives opportunity for renewed infection of dogs and probably of other carnivora. Thus the life cycle takes about a year for its completion, and is closely related to weather conditions.

It appears from a study of field conditions that gid is most prevalent in the winters following a spring when the rainfall is abundant, an opinion expressed by many European writers, and in places where the range is most thoroughly carpeted with forage. In parts of the plains country of southeastern Montana where the forage is largely bunch grass, the range has not yet become infected, in spite of giddy sheep brought in from the infected region. The infection seems to persist better in upland valleys such as the country bordering the Judith Basin, and around the mountains such as the Sweet Grass Hills and the Little Belt Mountains. In some of these infected localities the ground is covered with a moss in the spring, and it is said that the sheep are very fond of this. It seems evident that the washing about of feces deposited on such a moss carpet or on a range where the grass grows in a continuous mat would be more certain to leave tapeworm eggs where sheep would get them than feces deposited on the bare ground in a country where they could wash along on the ground between scattered bunches of grass. The necessity of watering sheep on summer range at shallow watering places and in reservoirs and ponds in coulees where contamination by dogs is inevitable must also play some part in the infection of sheep.

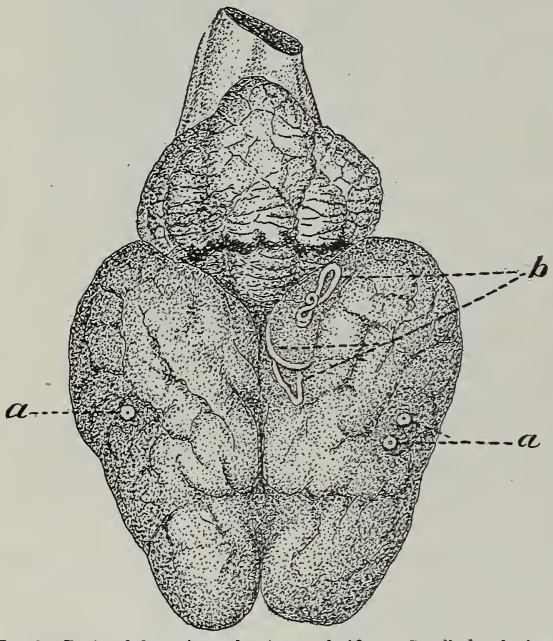

FIG. 6.—Brain of sheep in early stages of gid. *a*, Small developing parasites; *b*, channels due to wandering of parasites on surface of brain.

The writer learned of two instances in Montana where outbreaks of gid were believed to be due to feeding hay which had been contaminated by dogs which were allowed to sleep on it.

SYMPTOMS OF GID.

COMPARISON WITH SYMPTOMS OF LOCO POISONING.

In a general way the symptoms of gid in sheep are such that the sheepmen may be pardoned for confusing gid with loco disease, due to eating white loco weed (fig. 8). Close observation, however, will readily distinguish one from the other. Locoed sheep show symptoms of poisoning, while giddy sheep show evidences of brain trouble or more rarely of trouble in the spinal cord. Locoed sheep are nervous, uncertain in their movements, and out of condition, but they never show the regular automatic repetition of some unusual movement that giddy sheep show. Giddy sheep very commonly turn in a circle, a very characteristic symptom. The circle may be relatively large or very small, or the sheep may even pivot in one place. A giddy sheep will sometimes graze for awhile, then raise its head as if it had just thought of something and start off for it, swinging around in a circle and perhaps stopping and beginning to feed in the place from which it started. Later, the sheep will circle for hours without stopping. Less often the sheep will throw the head back and bolt in a straight line as if frightened, or perhaps put the head between the front legs and go stumbling forward. The head is often held to one side and may be raised or lowered. (See figs. 9 and 10.)

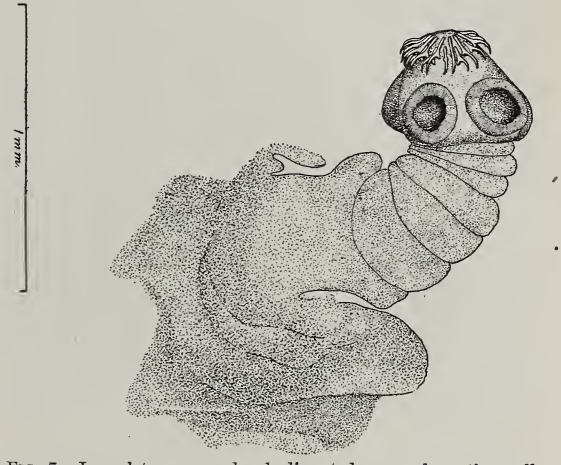

FIG. 7.—Larval tapeworm head dissected away from the wall of a gid bladderworm. (Specimen No. 3644, Bureau of Animal Industry helminthological collection.) (From Bureau of Animal Industry Bulletin 66.)

On the range the first symptom that the herder notices is that giddy sheep become hard to herd. They lag behind the flock, and when the dog is sent to bring them up, instead of running into the flock as normal sheep would, they run away from it. When the rest of the flock is standing quiet, giddy sheep can be seen worming restlessly about in it; and while the others are feeding, giddy sheep will be executing some meaningless maneuver, such as circling or running without any apparent cause.

Locoed sheep when put on alfalfa will nearly always recover; giddy sheep will show no abatement of symptoms and will invariably die unless operated on. When a sheepman has any doubt as to whether his sheep have gid or some disease which merely resembles gid, it will pay to kill a sheep and examine the brain. The developed gid para-

site is large and easily recognizable as a bag full of fluid, and its presence is proof that the sheep had gid. It is of course perfectly possible for a sheep to have loco disease and gid simultaneously, though no cases of this sort are known, so far as available records show.

COMPARISON WITH SYMPTOMS OF GRUB IN THE HEAD.

Sheep which are infected with so-called "grub in the head" (the larva of *Œstrus ovis*, the sheep gadfly) may sometimes be suspected of having gid. However, such sheep are characterized by a catarrh or "snotty nose," due to the irritation caused by the parasite in the nose and frontal sinuses. They do not show the automatic movements of giddy sheep. Grub in the head is rarely fatal, though sheep may die from a massive infection or from the larva or grub penetrating to the brain, a thing which it is claimed may happen in rare cases. The disease may be definitely diagnosed by a post-mortem examination of the back part of the nose and frontal sinuses, where grubs, similar to those shown in figure 11, will be found if the disease is "grub in the head." This disease is especially common in Sweet Grass County. Gid and grub in the head sometimes occur in the same sheep, as figure 11 indicates, and a sheep which circles may be suspected of having gid even though the presence of the *Œstrus* larvæ is also indicated.

FIG. 8.—White loco weed (*Aragallus lamberti*) in flower. (From Farmers' Bulletin 380.)

THE ERADICATION OF GID.

Knowing the life history of the gid parasite, the eradication of the disease becomes a very simple matter. It is only necessary to step in at some point where the parasite is most easily attacked and prevent its further development. This is accomplished in two ways: first, by destroying the heads, or at least the brains, of sheep dying of gid; and second, by keeping sheep dogs or other ranch dogs free of tapeworms. Of these two steps the first is much the more important, for the reason that it is much more practical and effective than the second and also is much easier.

FIG 9.—Giddy sheep on infected range in Cascade County, Montana. The sheep in front of the tree has gid and shows the characteristic circling attitude.

NECESSITY FOR DESTROYING HEADS AND BRAINS.

Claims have been made to the effect that the destruction of the heads of giddy sheep is unnecessary, on the ground that dogs do not eat sheep heads. In a former publication [a] the writer has shown the unlikelihood of scientists being mistaken as regards the life history of the gid parasite, and has shown by experiments that a dog not only would eat a sheep head, but having once eaten one, would subsequently go for the brains first of all when given a sheep head. It was shown that a dog would at times eat a skull so completely as to leave almost nothing, and at times lick the brains out through the foramen magnum and leave the skull apparently intact; in neither case would there be anything to suggest to the casual observer that a dog had eaten the brains. The writer has recently repeated this

[a] Bureau of Animal Industry Circular 159.

experiment and confirmed the earlier findings. A hound weighing 32 pounds was fed an unskinned sheep head, the tongue alone being removed. Three hours later the hound had eaten the brains and the entire back part of the skull, leaving only the nose and the upper and lower jaws. The next morning only the lower jawbones and the back part of the upper jawbones were left. The dog was then fed a sheep head which had had the top chopped in and the brains broken up and covered with 130 cubic centimeters (a pint equals about 568 cubic centimeters) of 5 per cent solution of formaldehyde. Inside of four hours the dog had eaten the brains in spite of this formalde-

FIG. 10.—A giddy sheep, shipped from Gildford, Mont., to Washington, D. C. The position of the head and neck and the emaciation are characteristic.

hyde, although it caused the brains to be vomited a little later. The next day the top of a sheep head was chopped in, the brains mashed up and covered with 200 cubic centimeters of coal oil and the oil set on fire. It burned for almost half an hour. The head was then given to the dog. The next morning the hound had eaten the brain and cleaned up the bones of the burned head. The next day a sheep head was split and the brains scooped out and covered with 100 cubic centimeters of turpentine. Three hours later the hound had eaten a small piece of the brains in spite of the turpentine. By the next noon he had eaten a little more. He was then fed a fresh set of brains

covered with 50 cubic centimeters of 40 per cent formaldehyde solution. These were untouched the next noon. Brains covered with 50 cubic centimeters of coal-tar-creosote, lime-and-sulphur, or cresol sheep dips were successively left with the dog for thirty hours and were untouched at the end of that time in all cases.

A somewhat similar set of experiments was meanwhile being carried on with a mongrel dog weighing about 30 pounds. This dog was fed a sheep head at the same time that the hound was fed the first head, but two days later he had only gnawed at the meat and had failed to get at the brain. The next day he was fed a sheep head the brain case of which had been broken up and the brains and head covered with coal oil and burned as above described. By the following day the brains had been eaten and the bones cleaned. A second sheep head which had been split open and not treated with chemicals of any sort was left with this dog all this day but was ignored. Brains taken out and treated with 100 cubic centimeters of turpentine were left untouched for twenty-eight hours. Brains treated with 50 cubic centimeters of 40 per cent formaldehyde solution were left untouched for eighteen hours, and then half of the brains was eaten, though it was of a rubbery consistency and must have been as indigestible as it was unpalatable. Brains covered with 50 cubic centimeters of coal-tar-creosote, lime-and-sulphur, or lime-and-tobacco sheep dips were untouched after being left with the dog thirty hours in each case.

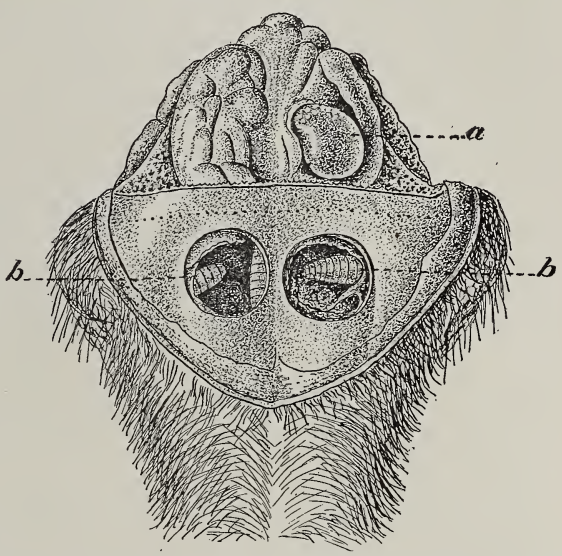

FIG. 11.—Simultaneous infection of sheep with gid and grub in the head. The gid parasite (*a*) is shown issuing from the brain. The grubs or *Œstrus* larvæ (*b*) are shown in the frontal sinuses, being exposed by openings made with a trephine. (After Moussu and Dollar, 1905, p. 468.)

The shepherd dog used in the experiment described in the writer's former article, already referred to, was fed an unskinned sheep head after an interval of over nine months since the first experiment. The first day some of the outer parts only were eaten in seven hours. After an interval of a day the head was fed again, and this time it was picked down to the bones, but the brain case was not entered. The remainder of the head was left overnight and the next morning

examination showed that the dog, following the method used on the former occasion, had licked out the brain through the foramen magnum, the opening where the spinal cord enters the brain. This opening had been enlarged little, if any, by the dog's teeth. A sheep head fed about a week later was treated the same way. The meat was eaten off the skull the first day and the brain licked out the evening of the second day.

Two coyote pups, between 5 and 6 months old and weighing, respectively, $12\frac{1}{4}$ and $14\frac{3}{4}$ pounds, were fed two unskinned and intact sheep heads. After forty-eight hours the coyotes had still been unable to get at the brains. The coyotes were too small and too young to permit of any conclusions in regard to the adult coyote being drawn from this fact. Indeed, it may safely be asserted that an adult coyote would have as little difficulty in getting at the brains as a dog would. A sheep brain covered with a lime-and-sulphur dip and one covered with a coal-tar dip were fed to the coyotes. Small parts of the brain covered with the lime and sulphur were eaten at once, in seven hours half of it was eaten, and in twenty-four hours it had all been eaten. The brain covered with coal-tar dip had been only partly eaten in the same time. After being fed one regular meal the coyotes were given one sheep brain covered with 40 per cent formaldehyde and one covered with turpentine. Eighteen hours later the coyotes had eaten both brains and had vomited them, owing to the formaldehyde and turpentine. A brain covered with 50 cubic centimeters of coal oil was eaten within half an hour and one which had been burned with the same amount of oil and some wool was eaten at once.

It is evident from the above experiments that some dogs, perhaps from being accustomed to cooked foods or to dainties, do not care much for sheep heads. The existence of such dogs is, however, of no consequence so long as dogs which do like sheep heads exist. It must be conceded that some dogs do like sheep heads and are especially fond of brains when they will eat them covered with formaldehyde or turpentine or burned in coal oil. The dogs used in the above experiments were fed the sheep heads and brains in place of their regular meals, and if the heads and brains were not eaten in thirty hours the dogs were put on their regular diet for a day or two. It is also evident that coyotes like sheep brains.

The evidence that dogs eat sheep brains, even where these are protected by the skull, is not entirely experimental. During the investigation in Montana, the writer asked a large number of sheepmen whether their dogs would eat sheep heads and the answer was never in the negative. Some did not know. Many claimed to have seen dogs eat sheep heads. One sheepman said he had seen a dog eat a sheep head and only leave a few splinters of bone uneaten. Another

stated that he had a dog which preferred sheep brains and would break open skulls to get them. Another stated that coyotes are fond of the brains of young sheep, and one man had seen what he took to be fragments of sheep skulls around coyote dens. Such testimony, fitting in, as it does, with the known facts and the experimental indications, must be held to more than offset the negative testimony of those who, in correspondence with the Bureau, claim that they know of no one who has seen dogs eating sheep skulls.

METHODS OF DESTROYING HEADS AND BRAINS.

One method of destroying heads of giddy sheep which the writer has advocated among Montana sheepmen is to burn the sheep head where this is practicable. One man whom the writer met in Montana claims to do this. Another burns them or throws them in an abandoned well. A plan which is quite as good or perhaps better is to split the head longitudinally with an ax or meat cleaver and get out the brain and burn it. This plan has the advantage that it does not require a quantity of wood, which is a scarce article over a large part of Montana's sheep ranges. The brain can be burned on a forkful of hay or straw and the parasite effectually destroyed. Coal oil in small amounts does not generate enough heat. Burning is practicable where wood or hay is available or where the sheep can be brought up to the home ranch and killed.

These conditions can not be met with in many cases, and the simple procedure advocated in such cases is to have the herder carry, as part of his wagon equipment (since most Montana herders work out from a wagon), an ax or a meat cleaver and a bottle or jug filled with any one of a number of fluids that would serve to kill the gid parasite and to discourage dogs or other carnivora from eating brains which had been covered with such substances. Among other things which a well-fed dog or a hungry and suspicious coyote would usually avoid are 40 per cent formaldehyde, turpentine, or the always available sheep dips of the coal-tar creosote, tobacco, and cresol varieties. Coal oil is too volatile, lacking in penetration, and not sufficiently repellent. The lime-and-sulphur dip might be used, but is not recommended, as it is not as strong or as repellent as the other things. The substances recommended have the advantage of being fatal to tapeworms on contact without being fatal to dogs, a point of interest to the man who must consider the possible danger to his sheep dogs. A dog might eat enough to make himself sick, but could hardly eat enough of such repellent substances to kill him, as vomiting would usually ensue and relieve the stomach. These substances need only be used in small quantities, and hence are easy to carry and inexpensive.

When a sheep becomes hard to herd, circles, or shows other definite signs of gid, it should be marked, a thing easily accomplished by tying a rag or something of the sort to the wool or about the neck, and when the band is brought up to the bedding ground for the night this sheep should be killed and the brain destroyed.

The best way to destroy the brain when it can not be burned is to split the skull longitudinally with an ax or cleaver, scoop out the two halves of the brain, chop them up or crush them, and pour on them turpentine, formaldehyde, or one of the sheep dips mentioned above. This operation takes only a minute or two, and the death of the gid parasite in the brain would follow in a few seconds after the application of the substances mentioned. A cleaver weighing 1½ pounds is heavy enough to split a sheep skull without difficulty. The brains should be completely covered with the turpentine or whatever is used, but even then it only requires a small amount to do the work. Fifty cubic centimeters (less than a tenth of a pint) would be sufficient if carefully applied, and while it would be undesirable to scant the amount, nevertheless a quart bottle would hold an ample supply for one herder for a season under ordinary conditions. Chopping in the top of the skull, and leaving the brains in place after breaking them up and covering with some repellent fluid, is not sufficiently thorough in actual practice. The fluid does not penetrate sufficiently and there is no saving of time.

In the experiment where the sheep heads or brains were burned with coal oil, an investigation of the part of the brain farthest from the burning oil showed that its temperature had been raised very little, probably not enough to have killed a specimen of the gid parasite at that point had one been present. This indicates that in those cases where the heads are to be boiled and fed to the dogs, the boiling should be prolonged and thorough, and the skull should be broken so as to give the hot water free access to the brain.

DISPOSAL OF GIDDY SHEEP.

When a giddy sheep has been killed and the brain disposed of by the method just given, the pelt may be taken and the meat disposed of as desired. The writer met only one man in Montana who used the meat of giddy sheep for food. The meat is fit for food at the beginning of the last stages of the disease, before neglect of food has starved the animal and brought on a condition of emaciation. At the same time the usual sentiment among sheepmen is that they are too much accustomed to the best mutton to eat sheep that were in any way diseased. The advice of European writers to market giddy sheep is not well taken, as a rule, in Montana. The disease occurs mostly in winter, at a time when the sheep are not in condition to market and when none are being marketed. But in case the meat is not to

be used for man it can be fed to the herder's dogs, or if the camp tender is around it can be fed to the dogs at the home ranch, or, as one outfit does, to the hogs.

In a general way, it is evident that the persistence and spread of gid in Montana is largely due to the sheepman's ignorance of the nature and means of prevention of the disease. But it is also due to a characteristic carelessness. For years sheepmen have carried on the sheep business in a large, liberal way that in some cases has degenerated into mere shiftlessness. It is one thing not to worry about the loss of two or three or a dozen sheep. It is another thing to let the loss stand and make no effort to find out what caused it, or, having found out what caused it, to take no steps to learn how to prevent a recurrence, or to apply such knowledge when learned. Such conduct is not businesslike, and is not creditable from any standpoint, and yet it is not uncommon to find Montana sheepmen doing these things. However, they are not common among the larger outfits. Big owners and camp tenders for big outfits commonly take account of these things and apply proper measures.

Over a large part of Montana when a sheep dies the carcass is allowed to lie where it falls, the pelt being usually, but not always, stripped off. At one point the writer has seen nearly a hundred carcasses lying along a well-traveled road. Such a condition aids in spreading a disease like gid. At other places dead sheep and cattle were lying in shallow watering places, and no one would take the trouble to drop a rope over them and drag them to a convenient coulee. Animal and bacterial parasites could find no conditions in nature more certain and satisfactory for their spread than those offered by the immersion of a carcass in a public watering place. A stream of clear mountain water at the home ranch of one big outfit was defiled by throwing into it the skeletons of sheep after the meat had been fed to the hogs. Big owners with excellent water supplies, amply able to afford concrete watering troughs, preferred to let their sheep drink the water after it had run into a hole in the ground and become converted into a stagnant puddle. Montana sheepmen must come to an appreciation of the fact that clean water is not only wholesome but profitable.

Many sheepmen maintain a hospital band at the home ranch, and the sick, weak, and crippled sheep from all the bands are brought in to this point and given a chance to recuperate. Some outfits kill those sheep which can not keep up, and take the pelt. Others, when a sheep can not keep up, let it drift and take a chance on picking it up again—a very small chance on an open prairie in coyote country.

It is in keeping with the careless practices mentioned above that some sheepmen refuse to bother with a disease like gid, which takes from the flocks from two or three to forty sheep yearly, on the ground

that it is too small a matter. Others claim that it is impossible to get sheep herders to do anything more than herd the sheep, which is often true. However, a realization that under some conditions the loss may amount to hundreds of sheep, together with the increasing value of sheep, will probably induce sheepmen to pay more attention to this disease, especially when it is realized that the avoidable neglect of a simple method of prevention endangers not only the flocks of the owner, but also those of his neighbors. As for the herders, it is usually true that the outfits with the hardest working owners and sheep foremen get the best service from their herders.

OPERATION AS A SUBSTITUTE FOR SLAUGHTER.

A number of Montana sheepmen, mostly Scotchmen, who have handled "sturdied" or giddy sheep in Scotland, prefer to operate for gid instead of killing the sheep and destroying the brain. Of the two operative methods usual elsewhere, the use of the trocar and of the trephine, the trocar method alone is used in Montana so far as the writer learned, although such simple methods as cutting out a piece of bone with a pocketknife and extracting the cyst, or puncturing the cyst with a pocketknife, are more or less common. The writer talked with one man who in addition to these methods had tried boring a hole in the skull with a knife blade and using a rubber syringe to suck out the parasite, and had also tried injecting a half teaspoonful of tincture of iodin and potassium iodid. Some men claim to save 50 per cent of sheep operated on, and claims were made of even higher percentages of success. Others, including one man who claimed to have operated on 50 sheep, had saved none.

It is commonly believed that operating instruments can be obtained only in Scotland or elsewhere in Europe. This is not correct. Trephine outfits can be purchased of any one of a number of makers of surgical instruments in the United States, and can be ordered from almost any druggist. Trocar outfits with cannula and syringe, designed expressly for operating on giddy sheep, can be imported through certain American firms. Such outfits, boxed, will cost up to $9. Nevertheless trocars, cannulas, and syringes similar to those in figure 14 can be made to order in this country at a cost of $5 or less. One or two sheep saved will pay for this. When a giddy sheep can not be marketed and will be fed to the dogs in any case, the sheep which die as a result of an operation are no loss, and those which are saved are clear gain.

Only the more favorable cases should be operated on. These are cases where the diagnosis indicates that the parasite is situated on the upper surface of the cerebrum, or large anterior part of the brain, and therefore accessible from an opening in the top of the skull. It is hardly possible always to locate a parasite accurately from the symp-

toms. The abnormal movements of the sheep are believed to be due to the everted tapeworm heads which irritate such parts of the brain as they come in contact with and thereby set up corresponding reactions. Inasmuch as a large cyst will have numerous heads capable of irritating the brain at relatively widely separated points, it will set up correspondingly variable reactions. At the same time certain symptoms will correctly indicate the location of the parasite in the majority of cases. Moreover, if the parasite is located on the upper surface of the brain it not uncommonly causes the formation of a soft spot in the skull just over the cyst, and this can be found by pressing firmly on the skull with the thumb till a place is found where the skull yields a little. As a rule, when such a place is pressed in the sheep will start violently. It may be that this is due to the pressure on the skull being communicated by hydrostatic pressure through the cyst, and thus causing the sudden simultaneous eversion of all or many of the tapeworm heads.

There are some sheep which can not be saved by operation. Some of these have the parasite in an inaccessible location at the base of the brain. Others have several parasites in the brain and their detection and successful removal may be impossible. Still others have the parasite located in the cerebellum, the small posterior part of the brain, or in the spinal cord, and can not be successfully operated on. Finally, the operator will not always be successful and some sheep will die of meningitis or some other complication.

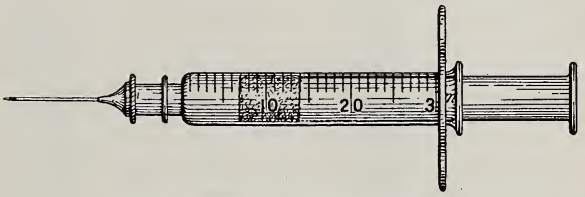

FIG. 12.—Glass hypodermic syringe.

For the purpose of the sheepman who wishes to perform the operation for gid, only those animals that circle should be operated on. In a majority of these cases the parasite will be located in the cerebrum near the surface and on the side toward which the sheep turns. The soft spot in the skull, if present, will usually be found on this side. The sheep will usually have a peculiar stare and will often run into things as if blind.

In any operation avoid the middle line of the skull and operate to one side, as the main blood vessels are located in the middle line. It is advisable to use a local anesthetic, such as cocain, as it not only lessens the suffering of the animal, but also makes the animal easier to handle and operate on as a result of the lessened pain. For the purpose of injecting cocain, a hypodermic syringe, with a capacity of 2 cubic centimeters, can be purchased for a trifling sum. (See fig. 12.)

If a trephine outfit is used the trephine should have about a five-eighths inch cut (fig. 13, *a*). Besides the trephine there will be needed a knife or scalpel (see fig. 13, *b*)—an ordinary pocketknife will serve, but is not so easy to sterilize—a pair of fine scissors with the blades bent at an angle to the handle (fig. 13, *c*), a pair of forceps (fig. 13, *d*), an ordinary pair of shears (fig. 13, *e*), a curved surgical needle (fig. 13, *f*), and some thread. Sterilize the instruments by boiling at a place convenient to the operation. Operate in a place sheltered,

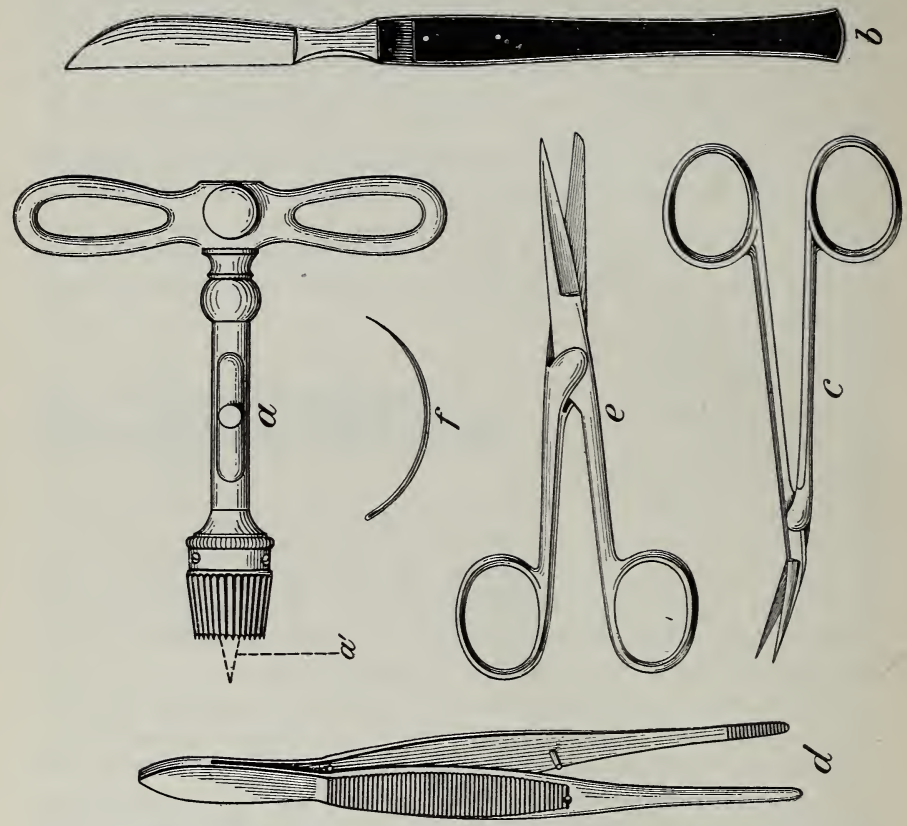

FIG. 13.—Instruments used in trephine operation. *a*, Trephine; *a'*, movable stylet of trephine; *b*, scalpel; *c*, fine scissors for cutting dura; *d*, forceps; *e*, scissors; *f*, surgical needle.

so far as possible, from wind and dust and sun, but with plenty of light to work by. The essential feature of the operation is cleanliness of the hands, of the instruments, and of the site of operation. It is useless to perform an operation of this sort in a careless fashion and with little regard for cleanliness, as the almost inevitable result will be a bacterial infection resulting in the death of the sheep and the loss of the time spent.

Inject 2 cubic centimeters of water with a one-eighth grain tablet of cocain dissolved in it at the site of operation, pushing the needle

through the skin and then moving it about so as to distribute the cocain all around the operation area. Shear the wool close over this area and for some distance around. Have the hands and the site of operation thoroughly cleaned with some antiseptic solution, such as 3 per cent carbolic acid solution (about a tablespoonful to the pint), or a solution of 1 to 1,000 potassium permanganate (put the amount of crystals that can be heaped on a quarter into a quart of water). Take the scalpel or knife and make a V-shaped incision with the place to be operated on included between the legs of the V. With the stylet of the trephine pushed out, start to cut, using the stylet to center the trephine. When the cut is started, draw back the stylet and cut till the bone breaks or is sawed through. In animals other than old rams with thick skulls it requires only a few turns of the wrist to accomplish this, and care must be taken not to press too hard. If the piece of bone comes out stuck in the trephine it can be removed with the stylet. If it does not come out, lift it out with the knife, breaking or cutting any unsawed adhesions. When bleeding occurs, sponge the bleeding parts with a piece of cotton batting or gauze moistened in the 3 per cent solution of carbolic acid or the 1 to 1,000 potassium permanganate solution. Make a cross-shaped cut in the hard membranous covering of the brain with the bent scissors, taking care to cut only the covering and not the brain.

If the parasite is located right at this point it will push out, oftentimes breaking, and may be grasped with a pair of forceps and drawn out. If it does not push out it may be sought for by inserting the forefinger, carefully washed in the antiseptic solution, into the opening and feeling around for a soft spot in the brain. If such a spot is found the finger may be drawn back and the parasite will usually follow it, and may be removed with the forceps. According to Pfab (1910),[a] the cavity of the brain from which the parasite was removed should be washed out by means of a syringe until all bleeding stops, even though it takes half an hour for it to stop. A weak antiseptic solution, such as a carbolic acid solution of one-half of 1 per cent, a solution of 1 part of corrosive sublimate to 5,000 parts of water, or a 3 per cent borax solution, would probably be satisfactory for this. Tablets of corrosive sublimate sufficient for making solutions of known strength in given amounts of water can be purchased of druggists. Corrosive sublimate is poisonous and corrodes metal on contact and must be handled accordingly, using glass receptacles and glass or rubber syringes. Boiled normal salt solution (1 teaspoonful of salt to a quart of water) may be used to syringe out the cavity. Inject the solution gently with a large sterilized syringe, then withdraw it, empty the syringe, and repeat with fresh solution.

[a] Münchner Tierärztliche Wochenschrift, Jahrgang 54, No. 7, pp. 109–114. München, February 15, 1910.

When the bleeding stops put the V-shaped flap of skin back in place and take a stitch through the tip of the V and a few along the upper side. Leave the other side free, and do not put back the piece of bone. This will give the wound a chance to drain and prevent the animal from dying of a pus accumulation on the brain. Cover the wound with a pad of cotton wrapped in gauze, or of gauze alone, the pad being moistened with 3 per cent carbolic or 1 to 1,000 potassium permanganate solution, and tie this in place with a strip of cloth. Keep the animal quiet and shut up in a darkened shed for a day or two. Should it show signs of fever and nervousness open the flap and syringe out the cavity again, closing the wound as before.

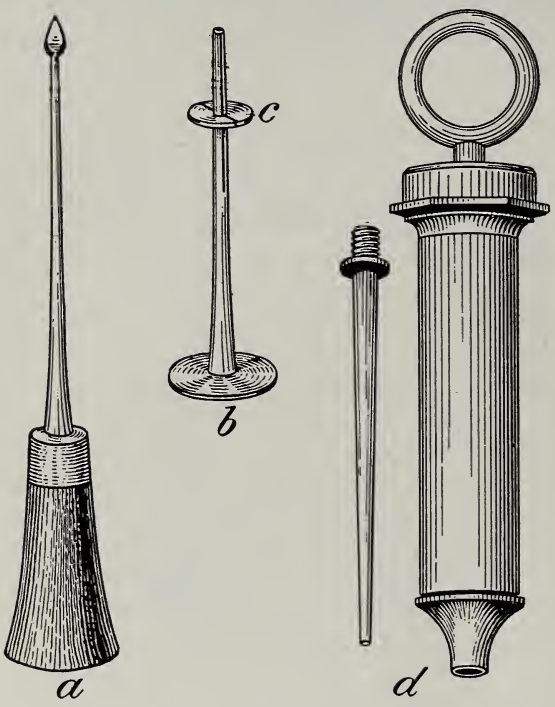

FIG. 14.—Instruments used in trocar operation. *a*, Trocar; *b*, cannula; *c*, guard (this is not present on most cannulas); *d*, syringe. (After Erdt, 1870, p. 88.)

The trephine operation permits the operator to examine the brain more thoroughly and makes the removal of the entire parasite easier and more certain than is the case in the trocar operation. These things and the fact that it is easier to procure suitable instruments in this country make it more suitable for American sheepmen than the trocar operation.

In using the trocar outfit, shear the wool from the area to be operated on and then shave a small place clean, using an antiseptic solution to disinfect the shaved area. Inject cocain under this. Insert the trocar (fig. 14*a*) in the cannula (fig. 14*b*). Drive the trocar and cannula carefully into the skull until it is evident that the skull is penetrated. They will go in very easily if the soft spot is struck. Most cannulas do not have the guard *c*, shown in figure 14, and care must be taken not to penetrate the brain too far. Withdraw the trocar, leaving the cannula in place. If the parasite is struck a flow of watery fluid should follow the withdrawal of the trocar. Insert the syringe (fig. 14*d*) in the cannula, and syringe out the fluid till no more will come. Then take off the syringe and withdraw the

cannula. The cannula should have a cleft at the end which is in the skull, and the parasite will often be caught in this. As the cannula is carefully withdrawn the parasite may be grasped with a pair of forceps and carefully drawn through the hole in the skull. Syringe out the cavity with a weak antiseptic solution as above directed till bleeding stops. Cover the whole with a pledget of cotton wrapped or sewed in gauze and soaked in the 3 per cent carbolic or the 1 to 1,000 potassium permanganate solution. Do not use pine tar or similar substances, as they do not permit of drainage. If the parasite is not struck the first time, a second or third spot may be selected and the trocar driven in.

The parasite should be destroyed. Burn it or put it in the strong antiseptic solution or in sheep dip. One sheepman told the writer that in operating on giddy sheep, and he had operated on quite a number, he threw the parasite away. This was almost the worst thing he could have done. The worst would have been to whistle for a sheep dog and feed it to the dog. That would have been only a little surer than throwing the parasite on the ground, as the two to ten sheep dogs around the home ranch of the average Montana sheep outfits would be almost certain to eat the parasite. Dogs sniff at such things out of curiosity, and eat them, perhaps, for the same reason. The writer has never yet seen a dog refuse to eat a bladder worm.

In passing, it should be said that all attempts to cure gid by the administration of medicine have proven failures. No cure of the sort is known.

ADMINISTRATION OF TAPEWORM MEDICINE TO DOGS.

As regards the administration of tapeworm medicine to dogs, many sheepmen think this is too much trouble, and many are puzzled by the names of strange medicines and unfamiliar terms of dosage. There are, however, some sheepmen who do give their dogs some tapeworm medicine. The best time to do this is after the outbreak of gid for the year is over and no more giddy sheep heads are available. This will usually be early in April, and in most seasons the dogs can be treated before being sent out on the summer range. This will eliminate the tapeworm before the advent of the rainy season starts the period of infection by washing the eggs onto the grass and into the drinking places. To safeguard against cases of gid which occur later than March, it would be a good idea to administer tapeworm medicine about four times a year, as new tapeworms develop from bladder worms in one or two months. This treatment could hardly be given while the dogs were on the range, and would require the temporary use of other dogs in order not to interfere with the herding. It is necessary that the dogs be tied up or confined while the medicine is given, in order that the tapeworms may be destroyed when passed.

The easiest and best way to destroy them is one which is used by a Montana sheepman. It consists in covering the worms and feces with a sufficient amount of hay or straw and burning them. Another way would be to bury the worms and feces with sheep dip, quicklime, or something of the sort. If the worms are put in some antiseptic solution, preferably formaldehyde or corrosive sublimate, and forwarded to the Bureau of Animal Industry, Washington, D. C., they will be identified and the sender notified as to whether they are gid tapeworms.

It is highly desirable that dogs should be treated for tapeworms. Not all dog tapeworms will cause gid in sheep, but they often develop injurious larval forms in man and the domestic animals, and they are all injurious to the dog. The fact that the dog belongs to the herder may be only an additional reason for insisting on giving it a dose of tapeworm medicine. The outbreak of gid in New York State was apparently derived from some dogs imported from Scotland, and it is altogether likely that dogs belonging to wandering sheep herders have brought gid from infected areas into many Montana flocks previously uninfected.

The following drugs may be used to rid dogs of tapeworms:

Pelletierine tannate. Very efficient, safe, and readily retained by the stomach.

Oleoresin of aspidium, or *ethereal extract of male fern.* Very reliable.

Kamala. Effective and convenient in that it acts as its own purgative as a rule. Sometimes advisable to follow by one of the purgatives mentioned later in this article.

Kousseïn, kusseïn, or brayerin. Very prompt and safe. Will act as a purgative, but should be followed by one of the purgatives noted below.

Areca nut. Good when freshly ground.

The dose for each of the above remedies is as follows: Pelletierine tannate, 5 to 15 grains; oleoresin of aspidium, 15 to 40 minims; kamala, 15 to 30 grains; kousseïn, 15 to 50 grains; areca nut, 20 to 50 grains. A sheep dog, weighing from 30 to 40 pounds, would require approximately the following amounts: Of pelletierine tannate, 10 grains; of oleoresin of aspidium, 30 minims; of kamala, 20 to 25 grains; of kousseïn, 30 grains; of areca nut, 35 to 40 grains.

For the purpose of the man who is unfamiliar with apothecaries' weights and measures, or who is in no position to weigh and measure in such fashion, the writer suggests that the drug desired, together with a box of No. 00 capsules, be purchased, and the amount of the drug be measured and administered in the capsule. There is a certain amount of variation in the amount of a powdered drug which can be placed in a capsule, owing to variations in the different lots of drugs, to variations of the same lot under varying conditions, and especially to variation in degree of compression. This is not of very great importance, however, as there is also a variation in the response to drugs of different dogs and of the same dog at different times. Give the 30 to 40 pound sheep dog 2 capsules full of pelletierine tannate, or 2 capsules

full of oleoresin of aspidium, or 2 to 2½ capsules full of kamala, or 5 capsules full of kousseïn, or 6 to 7 capsules full of areca nut. In the case of the powdered drugs the powder should be packed in the capsule by repeated tapping.

Where No. 00 capsules are not available when desired, other sizes may be purchased and the dose computed from the number of No. 00 capsules needed. The following table shows the relation of the No. 00 capsule to other capsules as regards capacity:

Number of capsule	00	0	1	2	3	4	5
Relative capacity	12	8	6	4	3	2	1

It is evident from this that it would take 12 times as many No. 5 capsules, 6 times as many No. 4 capsules, etc., of any drug as it would of No. 00 capsules.

Drugs should be purchased in small quantities and used while fresh, as they lose in strength and efficiency in most cases as they get older.

The method which the writer commonly employs in administering drugs to dogs is to push the capsule down the throat as far as possible with the right forefinger, working from the right side, while an assistant holds the dog with a piece of board in the left angle of the jaw to keep the dog from biting. Another way is to drop the capsules into the mouth and then hold back the head, keeping the piece of board in the angle of the jaw, and pour water in the mouth, holding the nose till the capsules are swallowed. Where it seems inadvisable to do these things, capsules may be fed in pieces of meat, or the drug may be fed in soup or milk, or in pills made up with honey and meal or molasses and meal.

The dog should be fed nothing but milk or left without food the evening before the medicine is to be given. It is sometimes advisable to give one or two grains of calomel at this time. The next morning administer the tapeworm medicine, but do not feed. Keep the dog shut up or tied up. If tied, it is advisable that a long rope be used, as some dogs object to defecating when tied with a short rope. After a couple of hours administer three to four grains of calomel, or one to two grains of podophyllin, or one to two drams of jalap, or a tablespoonful of magnesium sulphate. The calomel or podophyllin can be purchased in 1-grain pills of any druggist. Castor oil, in doses of an ounce or so, may be used, but is not recommended, for the reason that it appears in some cases to increase the solubility of the tapeworm medicine, all of which medicines are more or less poisonous, and so increases the likelihood of the medicine being taken into the dog's system with harmful or even fatal results.

The feces and worms should be burned with hay or buried with quicklime or sheep dip, as already advised.

As has been noted, the coyote probably carries the gid tapeworm. As the coyote can not be treated for tapeworms and is a difficult

animal to exterminate, it is evident that the most important measure in the elimination of gid is the destruction of the heads of giddy sheep.

FAVORABLE TIME FOR ERADICATION MEASURES.

The present is a particularly favorable time for the eradication of gid from Montana and thereby from the United States. The dry-land farmer is making his appearance all over Montana, and whether he will ultimately succeed or not, he has convinced a great many sheepmen that the end of the big range sheep industry in that State is in sight. Some have already gone out of business and others are planning to do so or at least to cut down their bands. For a time Montana will probably have fewer sheep and fewer sheepmen than for some years. Then if dry-land farming succeeds, the farmer will probably begin to raise sheep in small flocks, and there will be more sheep owners and perhaps more sheep than ever. In the meantime it is incumbent upon the Montana sheepman to do his share toward eradicating gid and saving his own bands and those of his neighbors from further loss on that score. An enlightened effort with very little expense or trouble, for two or three years, will leave a field clear of gid for the Montana sheep industry of the future, relieve the rest of the United States from the menace of such a disease within its borders, and in so doing eradicate from this country a disease which Europe has been unable to eradicate in more than half a century. In order that efforts at eradication may not be rendered ineffective through the importation of dogs infected with the gid tapeworm, the Secretary of Agriculture has issued an order, under date of November 25, 1910, providing that collie, shepherd, or sheep dogs imported into the United States be subjected to quarantine and inspection until the presence or absence of infection with this tapeworm can be ascertained.

In a recent article by Moussu (1910),[a] he states that gid in France is looked upon as an accidental affair which ordinarily takes only one or two victims out of a flock, and so is looked upon as of no real economic importance. In comment he states that he has known gid to take 50 to 400 sheep from one flock, thereby proving itself a true disaster and killing off the entire lamb crop for the year. He further notes that breeders regard gid in such outbreaks as a mysterious disease of unknown nature. These two things, carelessness and ignorance, are quite probably the explanation of the failure to eradicate gid from Europe as they have been the explanation of the failure in this country. It is to be hoped that increasing care and interest in this subject will characterize the future conduct of the Montana sheepmen.

[a] Journal d'Agriculture pratique, an. 74 (32), vol. 2, 11 août, pp. 175–177; (33), 18 août, pp. 213–215. Paris, 1910.

SUMMARY.

Gid has occurred in Montana for over twenty years and causes at times severe losses. It is usually confused with loco disease or other diseases. The losses and the history of the disease here and in Europe warrant prompt efforts at eradication.

The gid parasite, occurring as a bladderworm in the brain of the sheep, is transmitted to dogs by the latter eating the heads and brains of sheep dying in the last stages of gid. The heads on the bladderworm develop into tapeworms in the intestines of the dog, and the eggs formed by these tapeworms are passed onto the range or pasture and taken up by sheep in their food or water. From these eggs an embryo gets to the brain of the sheep and forms the gid parasite. There is absolutely no evidence to show that this life history of the gid parasite is incorrect.

The life cycle takes about a year for its completion and appears to be closely related to weather conditions. The weather and the nature of the forage appear to determine to some extent the amount of infection.

The symptoms of gid are very striking and readily distinguishable in most cases.

The eradication of gid is very easy. Destroy the heads or brains of giddy sheep, and keep sheep dogs and ranch dogs free of tapeworms. The first is the more important.

Destroy the heads by burning, or split the skull, scoop out the brains, chop them up or crush them, and cover them with turpentine, formaldehyde, or sheep dip. Ignorance and carelessness, resulting in leaving heads of giddy sheep to be eaten by dogs or coyotes, are responsible for the spread of gid in Montana.

Instead of killing giddy sheep and destroying the brain, the more favorable cases may be operated on if desired, taking care to destroy the parasite when it is removed from the brain.

Tapeworm remedies should be administered to dogs at least once a year when the outbreak of gid for the year is over. The medicines may be measured out in capsules in the amounts noted in the text. The tapeworms should be destroyed by burning or burying with quicklime or sheep dip.

The present is a particularly favorable time for eradicating gid from Montana and thus cleaning up the only area in the United States which is known to be thoroughly infected. Such eradication can only be accomplished by the care and interest of the sheepmen.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *November 14, 1910.*

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